Seventh Quarterly Report

AROMATIC ORGANIC LASER DEVELOPMENT

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I. INTRODUCTION

During the past quarter, progress towards the development of a laser employing fluorescent organic compounds has proceeded with emphasis upon obtaining the exact composition of polymer required to achieve the desired optical properties.

II. MATERIALS PREPARATION

The principal optical difficulty with polymer rods has been their birefringence. In the previous quarterly reports, it was shown that a material with a zero stress optical coefficient was necessary since the stress cannot be annealed out of the samples due to the second order glass-rubber transition, which must be passed through during the annealing process. Dibutylphthalate (DBP) is added to the methyl methacrylate monomer in order to reduce the stress optical coefficient. In the last quarterly report, the difficulties of making accurate measurements of the stress optical coefficient around the zero point were discussed. It proved impossible to measure the stress optical coefficient with sufficient accuracy. It was determined that 10% by weight DBP was approximately the right concentration for a zero stress optical coefficient. A series of polymers were prepared arranging from 9 to 11% DBP in 0.1% intervals. After annealing, those samples in the range of 10.4 to 10.6 per cent DBP were free of any birefringence with the 10.5% being the optimum concentration.

Surprisingly, the stress optical coefficient is not zero at this composition. What has apparently happened is the glass-rubber transition temperature (which is 40°C in pure polymethyl methacrylate) has been shifted downward below room temperature by the addition of the DBP. With the absence of this transition within the annealing temperature cycle, annealing to remove stresses in the sample is possible. For one sample measured, the birefringence was $\Delta n \doteq 6 \times 10^{-7}$.

During the past quarter refinements in the annealing techniques have also been accomplished. A proportional controller is used which very carefully regulates the annealing cycle. Samples are annealed at 110°C utilizing a heating rate of 10°C per hour, a three hour soak and a 2°C per hour cooling cycle.

Another refinement made on the samples in the last quarter included micropore filtering of the monomer solutions to remove small particles which would introduce scattering. The micropore filtering employed removed all particles larger than 0.5 microns in size. Scattering losses in the samples prepared using this filtering technique have been decreased significantly.

Several rods have been grown containing perylene and annealed. They are now being polished to optical tolerances for testing in the resonant cavity. The details of their preparation will be given in the semi-annual report.

III. DEVICE DEVELOPMENT

Some tentative results on the argon-theta-pinch lamp spectral measurements were given in the previous report. Some analysis of this data has been performed on results obtained with a 2.5 mm lamp. A continuum peaking in the range of 3500-4000 Å is observed. The irradiance of the lamps' continuum at its peak corresponds in brightness to about an 8,000-10,000°K blackbody. If the continuum were due to blackbody radiation, an 8,000°K source would peak at 3650 Å and a 10,000°K source at 2900 Å. Thus, it is not yet a clearcut case that the continuum is due to blackbody radiation. Other obvious possibilities are Bremstrahlung and recombination radiation.

On top of the continuum are a multitude of very narrow, very intense lines corresponding to atomic argon and to at least the first two ionized states of argon. The maximum output of the lines and continuum is between 3,000 Å and 4,500 Å, making the lamp quite suitable for pumping perylene.

An estimate of the total radiating power is very difficult due to the very narrow lines and to the difficulty of estimating the true radiating area of the lamp. However, a rough estimate of the radiating efficiency is that 1 to 10% of the electrical power is radiated as continuum between 2700 Å and 5700 Å. Since the lines contribute significantly to the brightness of the source, the source must be reasonably efficient in view of the fact that there are still significant circuit losses.

IV. PLANS FOR THE NEXT QUARTER

Pumping experiments will be performed on the good rods containing perylene which were grown and prepared during this past quarter.

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